Comparing time aggregation techniques in relation to capacity-expansion modeling

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Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

all investigated impact categories. The aim is also to investigate the influence of different perspectives on the importance of different environmental impacts. VIP-Analysis software was used, because it is an MCDA decision support tool using the additive model coping with incomplete information on the scaling constants, and these characteristics seem very useful to deal with the case study. The results will be presented and discussed from an OR point of view.

Note: Rogério Valle died in 2017

2 - Exploring the use of multi-criteria decision approaches for chemical alternatives analysis
Charles Corbett, Christian Beaudrie, Tom Lewandowski, Timothy Malloy, Xiaoying Zhou

Recent approaches to improving chemical safety focus on prevention, and involve comparing and evaluating a regulated chemical or process and its alternatives across a range of criteria. Alternatives analysis (AA) is a method for conducting such assessments, which are inherently multi-dimensional and based on incomplete and incommensurate information. Decision-makers typically use ad hoc narrative approaches to perform AA. We report on our findings from a workshop in which we conducted a series of AA exercises with 12 participants from businesses and government agencies. The participants conducted the first AA individually prior to the workshop, then during the workshop they performed another AA using (multi-criteria decision analysis), individually or in a small group, and a third AA using structured decision-making (SDM) in a group setting. We surveyed the participants after each of the AA exercises, and found that their confidence in and satisfaction with the decision and method varied widely across settings.

3 - Evidence for overcoming the efficiency gap by fully integrating the decision process
Christian Schützenhofer

An empirical and comparative analysis of the effectiveness of the internalization of efficiency management by ISO mgmt. systems vs. external audits. Literature documents many barriers to energy efficiency but few working methods to overcome these. In the case of firms we argue and provide supportive data for one such working policy. We propose the internalization of the management process of identification and organization of the implementation of efficiency measures via standardized processes. These are so called management systems as documented in ISO14001 (environmental mgmt. system) and ISO50001 (energy mgmt. system). We find supportive data of a cross section of industries in 48 Austrian large firms, realizing 165% more savings, measured by actual energy saved than the control group. Methods: Analytical: comparative analysis of documented energy efficiency barriers vs. prescribed management tools from ISO standards to circumvent them. Quantitative: comparison of firms' resulting savings from enacting measures of the two cases: firms provided with ideas via external energy audits and following their given management processes vs. internal management system audits and implementation via management process as prescribed by ISO14001 or ISO50001. Results: We found a 165% increase of savings compared to the base case of external audits and non-ISO certified energy management processes and abstracted the basic management methods leading to this success.

4 - Environmental impact assessment in supply chain design and planning models: goal and scope definition challenges
Bruna Mota, Ana Carvalho, Maria Isabel Gomes, Ana Barbosa-Povoa

Environmental concerns from stakeholders such as governments, customers and NGOs are increasing the pressure placed on companies. However, environmental impact assessment is not easily applicable in supply chain related decisions. Several environmental impact methodologies have been proposed in the literature and Life Cycle Assessment (LCA) has gained distinction and has been recommended by the European Commission as the most adequate and complete method currently available. This work specifically addresses the challenges in the "Goal and Scope definition" step within LCA in its application to supply chain design and planning models. Of the outmost importance, in this step several decisions are taken related to system boundaries as well as methods selection, which significantly influence the direction and potential outcomes of the study. This impact is assessed and analysed in this work. ToBLoOM (Triple Bottom Line Optimization Modelling), a multi-objective mixed integer linear programming model developed for the design and planning of sustainable supply chains, is applied to the supply chain of a company in the pulp and paper industry, specifically to the supply chain of uncoated wood free (UWF) paper. Different decisions taken at the "Goal and Scope" definition step are studied through different scenarios. Managerial insights on the application of environmental impact assessment methodologies in supply chain design and planning models are derived from this work.

■ MD-55

Monday, 14:30-16:00 - 4D UPV 2.1

Academic-Practitioner Discussion Panel

Stream: Making an Impact I
Chair: *John Hopes*

1 - Academic-practitioner discussion panel: getting the best from each other
Ruth Kaufman

Academics and practitioners have different incentives, and different contractual, personal and professional objectives, but there are considerable areas of overlap and opportunities to learn from each other. This is the third successive EURO conference to bring academics and practitioners together for a question-and-answer panel. Previous panels have considered the obstacles in the way of academic-practitioner collaboration, and ways of overcoming them. This panel will focus particularly on how we can get the best from each other: what would academics like practitioners to know and do, and vice versa. A brief recap of the conclusions from previous panels will be followed by short introductions from experienced academics and practitioners, followed by questions and contributions from the audience.

■ MD-56

Monday, 14:30-16:00 - 4D UPV 2.2

Optimization in Renewable Energy Systems III

Stream: Optimization in Renewable Energy Systems
Chair: *Andreas Bley*

1 - Comparing time aggregation techniques in relation to capacity-expansion modeling
Stefanie Buchholz

A high priority of green energy combined with a hard constraint of demand satisfaction causes system flexibility to be the core building block of a stable energy system. In order to both detect the need for flexibility as well as the optimal flexibility technologies satisfying these needs at minimum cost, the system should be analyzed on an hour-to-hour scale for a long period of time. This often leads to computationally intractable models and one way to regain tractability is to aggregate the time domain. Many different aggregation techniques have been developed all with a common goal of selecting representative time slices to be used instead of the full time scale, causing a model size reduction by the number of variables and/or constraints. The art of aggregation is to balance the model complexity against the solution quality, making validation of the techniques crucial. We come up with a couple of new aggregation techniques, which we validate according to the full size model but also compare to other techniques

from the literature. We look into the sensitivity of the performance of the techniques to different data sets and to different model features. With a focus on the complexity of the aggregation techniques, we try to answer the question whether more complex aggregations actually provide better estimates, and experimentally quantify the gains.

2 - European industries' energy efficiency and performance under different productive regimes, revealing the role of heterogeneity, path dependence and energy mix
Eirini Stergiou, Kostas Kounetas

Energy consists an indispensable input in production process and plays a crucial role on countries' growth and human development. Because of the strong and sustained economic growth that exists in the last decades, the demand for energy has been increased massively. In order to achieve environmental sustainable growth, EU has devoted sizable resources towards energy efficient and saving policies through the adoption of social and physical infrastructures to support CO2 mitigation and encourage sustainable development. We model a productive and energy efficient performance of European industries taking into account both desirable and undesirable outputs under a metafrontier framework for 27 European countries and 14 industrial sectors of manufacturing over the 1995-2011 period. This allows for a detailed consideration of the efficiency improvements made possible via technological spillovers within a given class of membership. In a first stage, DEA and DDF approaches were used for the estimation of productive performance, energy efficiency and technology gaps. In a second stage, GMM estimators are employed in order to investigate the endogenous relationship between energy efficiency and productive performance and the role of the implied technology as it is conveyed by the level of each country. Moreover, we investigate the role of energy mix, the existence of path dependence of technology heterogeneity in conjunction with the role of the corresponding group membership.

3 - Uncertainties and impacts of the demand response in the European power system
Héctor Marañón-Ledesma

An optimal planning of the energy transition is crucial to assess the right long-term investments. The so called "winter package" by the European Comission (EC) includes among other measures empowering electricity consumers, allow them to provide and consume flexibility. It is left to see what amounts of energy flexibility consumers will reach in this framework regulation. The question that we want to answer is how the power system develops considering the challenges and uncertainties of DR flexibility. By means of the European Model for Power Investments with Renewable Energy (EMPIRE), the long-term development of the power sector until 2050 is analyzed. The stochastic optimization model EMPIRE uses a multi-horizon approach that consists of decoupling the short-term operation and the long-term strategic dynamics. By changing the limits on potential DR capacities and DR investment costs, three possible development scenarios for DR are created. With a stochastic optimization multi-horizon model we study the impacts of long-term DR uncertainty. The results of the stochastic solution show sensible DR investments before uncertainty is revealed. Due to the large solar capacities expected for 2035 and the support that DR can offer to RES integration, flexible consumers are system-wise efficient even when considering pessimistic scenarios. Flexibility supplied by DR loads partially substitutes battery storage capacity in each scenario and decreases system costs.

4 - A Lagrangian solution approach for multi-sector energy system optimization
Andreas Bley, Frank Fischer, Angela Pape

We consider the problem of optimizing the strategic development of a national energy supply system over multiple incremental planning stages. Our model includes several energy sectors with numerous types of power demands and generation and storage technologies, a high penetration of renewable energies, several cross-sector power transformation options, the underlying transportation networks, and several scenario-depending technical, economical and political parameters. While design and dimensioning decisions are described per planning stage, power productions, consumption and flows are modeled using a time-series per stage. This leads to optimization models that are computationally unsolvable in practice, even for very small test examples. In this talk, we present a Lagrangian solution approach to solve this problem. The approach combines a Lagrangian relaxation, which relaxes several coupling constrains and decomposes the problem into independent unit-commitment-type problems in order to compute globally valid lower bounds, and some problem tailored heuristics that compute near-optimal globally valid solutions based on the relaxation's solution. The proposed approach runs substantially faster than solving the complete model using a state-of-the-art solver and permits the solution of real-world size problems.

■ MD-57

Monday, 14:30-16:00 - 4D UPV 2.3

Data Analytics for Bioinformatics

Stream: Computational Biology, Bioinformatics and Medicine
Chair: *Sofiane Oussedik*

1 - Quality criteria for supply optimization: study case in an oncological healthcare institution
Juan Pablo Zamora Aguas, Oscar Mayorga T., Jair Eduardo Rocha-Gonzalez

This paper presents an optimization model for the decision making of supply operations. Which includes the quality concept for operational cost reduce. The context of the research is about oncological drugs supply chain in a Colombian Healthcare Institution. In this study, the poor quality of the medicines as related to the defects due to failures in the storage and distribution processes (Newton et al., 2011). The quality of the health services are consequence of logistics risk in Healthcare Institutions (Zamora Aguas, Adarme, & Arango Serna, 2013). The lack of controls in the supply chain has been one of the causes of the poor quality of medicines (Hetzel et al., 2014). In Colombia, 8,26% of medicines evaluated between 2006 and 2010, had failures due to expiration, damages in packages and packaging (Pribluda et al., 2012). The quality failures of oncological drugs in supply chain operations were analyzed. The poor quality in operational and administrative logistics was considered. The parameters associated with supply chain operations and quality, were established. A mixed-integer linear programming model was proposed, and an scenario evaluation for to improve the impact on oncological healthcare services was done.

2 - The use of continuous-time Markov models to disentangle differences in patterns of long-term functioning for children with attention-deficit/hyperactivity disorder
Qi Cao, Roel Frerikx, Jurjen van der Schans, Annabeth Groenman, Pieter Hoekstra, Maarten Postma, Erik Buskens, Jochen Mierau

Purpose: We aim to validate the use of Markov models to disentangle patterns of long-term functioning for children with Attention-Deficit/Hyperactivity Disorder (ADHD). Methods: Data is retrieved from the Multimodal Treatment Study of ADHD (MTA). Three states of functioning were developed based on a six-point delinquency scale. Differences in patterns of long-term functioning between the ADHD and non-ADHD cohort were estimated with an ordered logit model and illustrated with transition matrices. Subgroups within the ADHD cohort were established based on four treatment modes. Treatment effects within the ADHD cohort were determined with a two-part model. With a continuous-time Markov model patterns of long-term functioning of children within the ADHD cohort were predicted over a ten-year period and validated against the observed data. Results: We found statistically significant differences in level and patterns of functioning between the ADHD and non-ADHD cohort ($P<0.01$). No treatment effects were found within the ADHD cohort ($P>0.10$). Good validation results were depicted with the predicted average probability of not